

ORIGINAL ARTICLE

Autonomic nervous system education in Europe: EAN/EFAS/INUS survey on curricula and skills in autonomic medicine of European neurology residents and consultants

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Abstract

Background and purpose: Centers for training in autonomic nervous system (ANS) disorders are not widely available and the recent coronavirus 2019 pandemic temporarily reduced training opportunities in autonomic medicine across European countries. Here we evaluated the current state of education, clinical skills and postgraduate educational preferences on ANS disorders of European neurology residents and consultants.

Methods: A 23-item questionnaire was developed and distributed online amongst European neurology residents and consultants via mailing lists of the European Academy of Neurology. The questions assessed demographics, current training opportunities and learning preferences in ANS disorders. Six multiple-choice questions were used to self-evaluate knowledge of ANS disorders.

Results: In all, 285 individuals answered the survey (60% female, mostly 25–34 years of age). All respondents considered clinical autonomic skills necessary for good clinical neurological practice, and 92% would like to increase their ANS knowledge. Female respondents and those who trained in Southern/Eastern/Greater Europe more frequently judged ANS skills important for clinical practice than male respondents ($p=0.012$) and respondents from Northern/Western Europe ($p=0.011$). Female and younger respondents felt less confident in managing ANS disorders ($p=0.001$ and $p<0.001$, respectively). Respondents below 45 years of age ($p<0.001$) and those with lower confidence in managing ANS disorders ($p=0.004$) were more likely to recommend that ANS education is embedded in the residency curriculum.

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Conclusions: Most European neurology residents and consultants reported a need for more autonomic education, with additional gender, age and regional differences. These findings underscore the importance of increasing the educational content on autonomic medicine in European medical and postgraduate curricula.

KEYWORDS

autonomic nervous system disorders, clinical neurology, medical education, residency program

INTRODUCTION

The autonomic nervous system (ANS) controls multiple physiological systems across the body and its dysfunction can therefore present with multiple symptoms. Practicing neurologists often manage a variety of autonomic disorders, both frequent, such as reflex syncope, and rare. ANS dysfunction also frequently develops in common neurological (e.g., movement disorders, multiple sclerosis, neuropathies, epilepsy, stroke) and systemic disorders (e.g., diabetes mellitus). Clinical management of all these conditions therefore requires well-founded knowledge on the principles of autonomic medicine that often cross borders between neurology and allied specialties [1].

The 2021 European Training Requirements for Neurology underscore the importance of a structured neurological education [2]. This document, endorsed by the European Union of Medical Specialists and developed with contributions from the European Academy of Neurology (EAN), places autonomic disorders as one of the 12 crucial neurological areas requiring recognition and adequate training. It lacks specific learning objectives and competencies, however, that should be acquired in autonomic medicine. This gap may be attributed to various factors, including differences in training curricula across countries, yet represents a substantial drawback for securing that neurology trainees are confidently capable of managing the multifaceted presentation of autonomic disorders in clinical practice [3].

In recent years, the EAN Scientific Panel for ANS disorders and the European Federation of Autonomic Societies (EFAS) mapped autonomic referral centers across European countries and found that a significant disparity exists in the availability of centers and educational opportunities between South/East/Greater and North/West European countries [4, 5]. The coronavirus 2019 (COVID-19) pandemic further exacerbated disparities in clinical autonomic healthcare, research and education, despite their importance for managing individuals with post-COVID autonomic disturbances [6, 7]. The detrimental impact of the COVID-19 pandemic on education in neurology subspecialties was also echoed by several recent studies amongst European neurology trainees [8–10].

The present EAN/EFAS/INUS (International Neuro-Urology Society) study aimed to evaluate the current state of autonomic education, skills and postgraduate educational preferences of European neurology residents and consultants.

METHODS

In spring 2023, a panel of EAN, EFAS and INUS representatives (the present authors, $n=24$) developed a web-based survey on the autonomic curricula, skills and educational preferences of European neurology residents and consultants. The study protocol and survey were drafted by D.R.C. and A.F., reviewed, revised and approved by all panel members, the EFAS Council and the EAN Scientific Committee on 20 July 2023. On 1 September 2023, the survey was launched on a web-based platform (Survey Monkey Momentive Europe UC, Dublin, Ireland); 1199 full and 1524 resident and research fellow EAN members were invited by email to complete it by 30 September 2023. A reminder was sent 1 week before the deadline. A minimum of 200 respondents was required per protocol for proceeding to data analysis. This target sample size was chosen considering the number of respondents to previous EAN surveys on other neurology subspecialties (i.e., neurogenetics) [11].

The survey entailed 23 questions inquiring about (see full text in Appendix S1)

- (i) demographic characteristics of the survey participants, years of neurological practice and practice setting (eight questions);
- (ii) personal pre-graduate and postgraduate education in ANS disorders (five questions);
- (iii) personal confidence in managing ANS disorders and autonomic educational preferences (four questions);
- (iv) self-assessment of autonomic skills with six multiple-choice questions.

No ethical approval was required for a survey amongst health-care providers. Participants gave their electronic informed consent for participating in the study. The study was performed in adherence with the current European Data Protection Regulations.

Statistical analysis

Qualitative data derived from each survey question were summarized in frequency and percentage and compared with the chi-squared test. It was first determined whether there was an association between the respondent's characteristics (age, gender and country of training/working), level of confidence in managing ANS

disorders and self-assessed skills in autonomic medicine with the type of autonomic pre-graduate and postgraduate training received. The associations between the abovementioned variables and the degree of self-confidence in managing ANS disorders, perception of the importance of ANS skills in clinical practice, need to increase the personal knowledge in autonomic medicine and preferred educational formats were also assessed.

For comparative purposes, respondents were divided into residents and consultant neurologists with less than 10 and more than 10 years of practice (including those already retired). Regarding age, participants were divided into two groups with a cut-off value of 45 years to capture differences in the educational offer and preferences across generations.

Questions related to the autonomic pre-graduate and postgraduate education enabled multiple choices (i.e., autonomic training in different medical courses, residency rotations or in multiple ANS domains). In this case, the sum of the responses that each participant gave for a given variable was also considered and tabulated as follows: no response applied, only one response, or more than one response chosen.

Regarding the personal confidence level in managing autonomic disorders, respondents were grouped into those self-rating their confidence as less/equal versus above 5 on a 1–10 scale for each ANS field. Their responses were further grouped into three categories: participants with low level of confidence in all ANS fields, or with high confidence level in one or multiple ANS fields (Table S1).

To analyze geographical differences, the same United Nations' geoscheme for Northern/Western versus Southern/Eastern/Greater Europe used in previous European ANS studies was applied [4]. This geoscheme was chosen for statistical convenience without assumptions regarding political or other affiliations of countries or territories.

Multinomial logistic regression analysis was performed to define which parameters that showed significant association (gender, age, geographical localization) predicted specific outputs (e.g., importance of autonomic skills, confidence, and need to increase the personal knowledge in autonomic medicine).

The statistical analysis was performed with SPSS-v25 (IBM Corporation, USA) and statistical significance was set at two-sided $p < 0.05$. When applicable, a Bonferroni correction was used to account for multiple comparisons. It is confirmed that the data supporting the present findings are available in the article and its supplementary materials.

RESULTS

Demographic data

In all, 285 individuals (60% female) from 33 countries completed the survey (see Table 1 and Figure 1). The respondent's rate was higher amongst the EAN full members (17%) than the resident and

research fellows (5%). Seventy-five percent of respondents had trained in neurology in Southern/Eastern/Greater Europe ($n = 215$). Country-wise, most respondents had trained in Croatia and Italy ($n = 40$ participants each, 14%), followed by Romania ($n = 31$, 11%) and Turkey ($n = 22$, 7%). Occasionally, neurologists had switched between European regions since training ($n = 11$, 4%).

Most respondents were 25–34 years old ($n = 131$; 46%), actively practicing in neurology ($n = 269$, 95%), most frequently for more than 10 years ($n = 104$, 37%) and in university hospitals ($n = 192$, 67%). There was a higher proportion of women amongst respondents below 45 years of age and those with fewer years of clinical practice, including residents ($p = 0.008$ and $p = 0.044$, respectively).

The most frequent neurology subspecialty of the respondents was stroke/vascular neurology ($n = 88$, 31%). Forty responders (14%) were specialized in ANS disorders, mostly with additional subspecialties ($p < 0.001$). Overall, 44% ($n = 155$) of respondents had multiple subspecialties.

Education in autonomic medicine

Ten percent ($n = 27$) of the respondents stated that they had no ANS training at all during their medical studies (Table 2). Pre-graduate ANS training was otherwise most frequently embedded in the neurology curriculum ($n = 229$, 80%), and in multiple disciplines for about half of the respondents ($n = 137$, 48%). People working in South/East/Greater European countries at the time of survey completion were taught autonomic medicine in a higher number of disciplines in medical school ($p = 0.022$). No differences in autonomic training during medical school based on the respondent's characteristics were otherwise observed.

When asked about formal training in autonomic medicine during residency, figures revealed that one-third of respondents ($n = 91$, 32%) had no contact at all with ANS disorders during neurology training. The remaining participants mentioned that ANS topics were mostly discussed within rotations in other subspecialties ($n = 134$, 47%). Compulsory rotations ($n = 13$, 5%) or educational courses ($n = 21$, 7%) in autonomic medicine were rare and, if then, more frequent amongst respondents below 45 years of age ($p = 0.045$) or less than 10 years of practice ($p = 0.004$). Respondents from Northern/Western Europe had more frequently a facultative ANS rotation during residency than those from Southern/Eastern/Greater Europe ($p = 0.039$) and contact with more ANS fields ($p = 0.029$).

Cardiovascular autonomic disorders were the most frequent field of autonomic training during residency ($n = 180$, 63%), followed by bladder ($n = 96$, 34%), bowel ($n = 51$, 18%), sexual ($n = 35$, 12%), thermoregulatory ($n = 47$, 17%) and ophthalmological disorders ($n = 36$, 13%) (Figure 2a). Forty percent of the responders trained in multiple autonomic fields during their residency. Training did not exceed 25 h per field, however, in the vast majority of cases (Table 2).

TABLE 1 Demographics, neurology subspecialty and work setting of the survey respondents.

Total number of responders	285
Gender (female)	170 (60%)
Age	
18-24	2 (1%)
25-34	131 (46%)
35-44	68 (24%)
45-54	33 (12%)
55-64	34 (12%)
65+	17 (6%)
Country of training	
Southern/Eastern/Greater Europe	215 (75%)
Northern/Western Europe	70 (25%)
Country of current work	
Southern/Eastern/Greater Europe	210 (74%)
Northern/Western Europe	75 (26%)
Years of practice in neurology	
Resident	77 (27%)
Less than 10 years	88 (31%)
More than 10 years (including those who are retired)	120 (42%)
Neurology subspecialty	
Stroke/vascular neurology	88 (31%)
Movement disorders	75 (26%)
Multiple sclerosis/neuroimmunology	63 (22%)
Dementia and cognitive disorders	51 (18%)
Headache and pain	47 (17%)
Clinical neurophysiology	43 (15%)
ANS disorders	40 (14%)
Neuromuscular disorders	40 (14%)
Epilepsy	38 (13%)
Neurocritical care	24 (8%)
Neurological emergency	24 (8%)
Sleep disorders	20 (7%)
Neurogenetics	19 (7%)
Neurorehabilitation	15 (5%)
Neuroinfectious disorders	12 (4%)
Neuro-urology	4 (1%)
Number of neurological subspecialties	
None/general neurology	19 (7%)
One	111 (39%)
More than one	155 (54%)
If the respondent is an autonomic specialist, was there an additional neurological subspecialty?	N=40
Movement disorders	25 (63%)
Dementia and cognitive disorders	11 (28%)
Headache and pain	11 (28%)
Multiple sclerosis/neuroimmunology	10 (25%)

TABLE 1 (Continued)

Total number of responders	285
Stroke/vascular neurology	10 (25%)
Clinical neurophysiology	8 (20%)
Epilepsy	6 (15%)
Neurocritical care	6 (15%)
Neuromuscular disorders	6 (15%)
Neuroinfectious disorders	5 (13%)
Neurological emergency	5 (13%)
Sleep disorders	5 (13%)
Neurogenetics	4 (10%)
Neurorehabilitation	3 (8%)
Neuro-urology	3 (8%)
Setting of current practice	
Public hospital	99 (35%)
University hospital	192 (67%)
Private clinic	31 (11%)
Private practice	30 (11%)
Other	4 (1%)
Not applicable	5 (2%)

Abbreviation: ANS, autonomic nervous system.

Importance of ANS skills and personal confidence in managing ANS disorders

When asked about the importance of autonomic skills for good neurological practice, most respondents answered that these are “important” ($n=125$, 44%) or “very important” ($n=132$, 46%, [Table 3](#)). The years of clinical practice and self-confidence had no relationship with such judgment, but both female participants ($p=0.012$) and people trained or working in Southern/Eastern/Greater Europe ($p=0.011$ and $p=0.009$) rated ANS skills on average of higher importance. On multinomial regression analysis, no gender or geographical preponderance was found amongst the respondents stating that ANS skills are “very important” for clinical practice. Autonomic specialists reported more frequently that ANS skills are “very important” ($p<0.001$).

Confidence in managing autonomic disorders varied substantially depending on the autonomic field in focus, with 77% of participants reporting good confidence in managing syncope and other cardiovascular autonomic disorders, and less than one-third feeling well acquainted with the treatment of bowel, sexual, thermoregulatory and ophthalmological disorders ([Table 3](#) and [Figure 2b](#)). Seventeen percent of the responders reported low levels of confidence in all ANS fields ($n=49$), but the majority felt confident in treating multiple ANS domains ($n=156$, 55%).

When comparing confidence levels in autonomic medicine with the autonomic training received during residency, those who had no training at all reported lower levels of confidence ($p=0.0024$), especially for treating syncope ($p=0.023$), bladder ($p<0.001$) and bowel complaints ($p=0.023$). Respondents who had received scattered

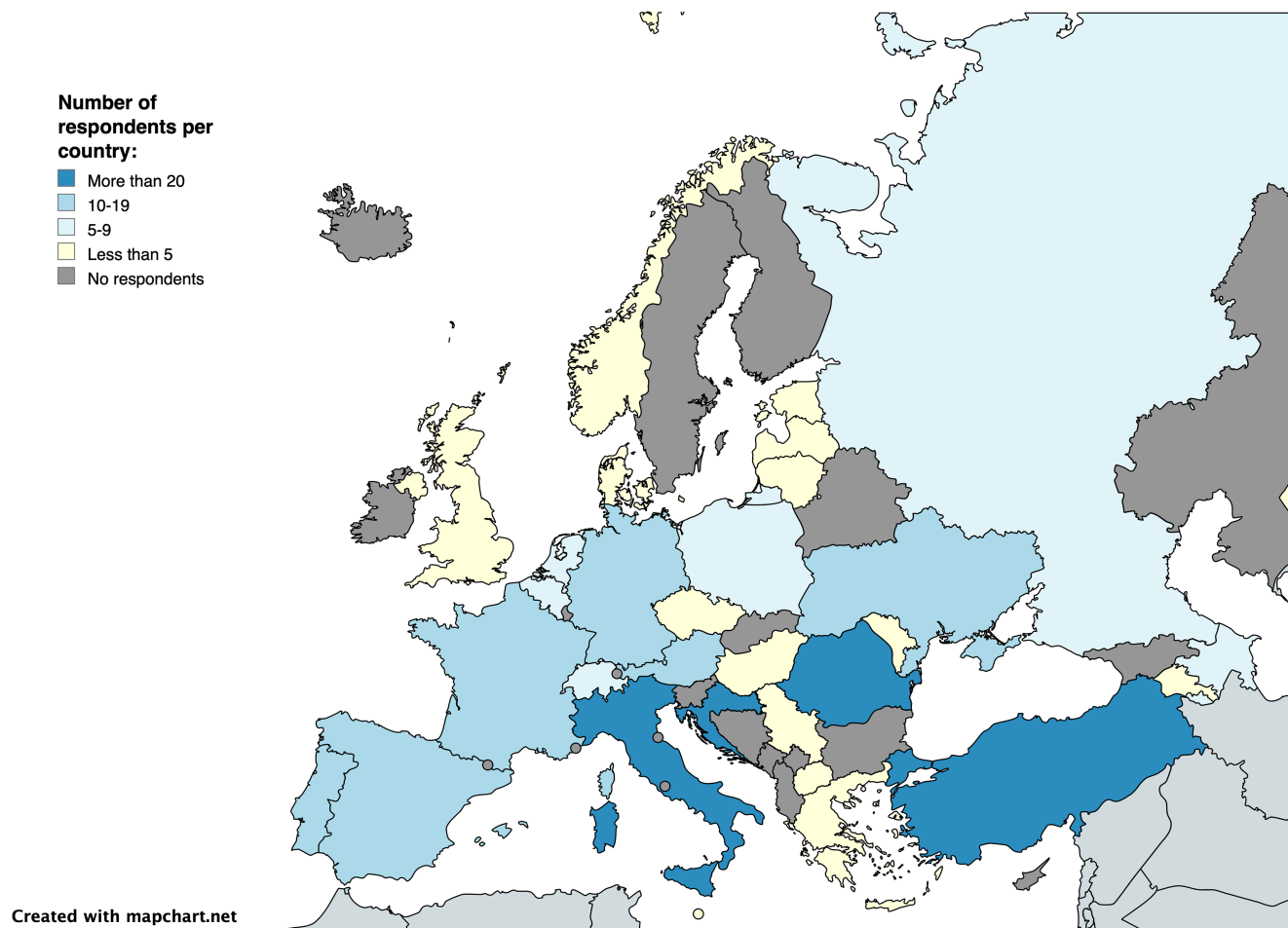


FIGURE 1 Number of survey respondents per country. To analyze geographical differences, the United Nations' geoscheme for Europe (available under <https://unstats.un.org/unsd/methodology/m49/>) was applied in the following way: (1) Eastern Europe: Belarus, Bulgaria, Czech Republic, Hungary, Poland, Moldova, Romania, Russia, Slovakia, Ukraine; (2) Western Europe: Austria, Belgium, France, Germany, Liechtenstein, Luxembourg, Monaco, Netherlands, Switzerland; (3) Northern Europe: Denmark, Estonia, Finland, Iceland, Ireland, Latvia, Lithuania, Norway, Sweden, United Kingdom; (4) Southern Europe: Albania, Andorra, Bosnia and Herzegovina, Croatia, Greece, Holy See, Italy, Kosovo, Malta, Montenegro, North Macedonia, Portugal, San Marino, Serbia, Slovenia, Spain; (5) Greater Europe: Turkey, Cyprus, Armenia, Georgia, Kazakhstan, Azerbaijan. There were no responders from the following countries: Andorra, Belarus, Bulgaria, Bosnia-Herzegovina, Faroe Islands, Finland, Gibraltar, Iceland, Ireland, Liechtenstein, Luxembourg, Monaco, Montenegro, San Marino, Slovakia, Slovenia and Sweden. Created using <https://mapchart.net/europe.html>. This work is licensed under a Creative Commons Attribution-ShareAlike 4.0 International License.

autonomic education also reported uncertainties in managing different autonomic disorders. For example, low confidence in managing sexual ($p=0.006$) and bowel dysfunction ($p=0.029$) were reported by those who had facultative rotations or educational courses during their residency. When autonomic medicine was embedded in another educational course or rotation, uncertainties persisted for managing syncope ($p=0.010$), thermoregulatory ($p=0.029$) and bladder disorders ($p=0.031$). Overall, the lower the number of residency rotations entailing autonomic educational contents was, the less confident the respondents felt in managing autonomic disorders ($p=0.016$), especially in the bladder ($p=0.001$) and sexual domain ($p=0.003$).

On the other hand, male respondents and those above 45-years-old reported higher levels of confidence in treating ANS disorders ($p=0.001$ and $p<0.001$, Table S2). When combining age and

gender in a multinomial regression model, female respondents were more likely to report low confidence levels in all ANS fields (2.953, 95% confidence interval [CI] 1.257–6.940), and respondents below 45 years of age were less likely to feel confident in multiple ANS fields (odds ratio [OR] 0.369, 95% CI 0.192–0.708).

Respondents who trained in multiple autonomic domains during their residency also felt more confident in treating autonomic disorders ($p=0.004$), especially concerning bladder ($p=0.001$), bowel (0.001) and sexual disturbances ($p<0.001$). More hours of training equally translated into more confidence in autonomic medicine, especially for managing ophthalmological ($p<0.001$), thermoregulatory ($p<0.001$) and sexual dysfunction ($p=0.002$). Respondents specialized in autonomic medicine reported similar levels of confidence to those who were not.

TABLE 2 Education in autonomic nervous system disorders.

Medical school	
Curriculum in which ANS disorders were discussed during medical school	
Neurology	229 (80%)
Cardiology	100 (35%)
Internal medicine	75 (26%)
Gastroenterology	39 (14%)
Urology	27 (10%)
Endocrinology	20 (7%)
Geriatrics	6 (2%)
Ophthalmology	6 (2%)
Pneumology	2 (1%)
Not discussed at all	27 (10%)
Number of disciplines in which ANS disorders were discussed during medical school	
None	27 (10%)
One	121 (42%)
More than one	137 (48%)
Neurology training	
Formal training received in ANS disorders	
Compulsory rotation during the residency	13 (5%)
Compulsory educational course during the residency	21 (7%)
Facultative rotation during the residency	17 (6%)
Facultative educational course in the residency context	26 (9%)
Part of another educational course (e.g., postgraduate courses, congresses)	75 (26%)
Autonomic topics were discussed within other rotations (i.e., movement disorders, clinical neurophysiology etc.)	134 (47%)
No training at all	91 (32%)
Subspecialty/rotation in which ANS training was received during residency	
Movement disorders	85 (30%)
ANS disorders	57 (20%)
Clinical neurophysiology	57 (20%)
Neuromuscular disorders	33 (12%)
Multiple sclerosis/neuroimmunology	31 (11%)
Dementia and cognitive disorders	22 (8%)
Stroke/vascular neurology	21 (7%)
Neurocritical care	16 (6%)
Epilepsy	15 (5%)
Neurological emergency	11 (4%)
Headache and pain	9 (3%)
Neurorehabilitation	6 (2%)
Sleep disorders	6 (2%)
Neuro-urology	5 (2%)

TABLE 2 (Continued)

Neurology training	
Neuroinfectious disorders	4 (1%)
Neurogenetics	1 (1%)
Number of subspecialties/rotations in which ANS training was received during residency	
None	100 (35%)
One	84 (30%)
More than one	101 (35%)
Number of autonomic fields of training during residency	
None	91 (32%)
One	80 (28%)
More than one	114 (40%)

Abbreviation: ANS, autonomic nervous system.

Educational needs and preferences in autonomic medicine

Most respondents expressed a need to improve their skills in autonomic medicine ($n=261$, 92%), especially female respondents ($p=0.014$) and those who trained ($p=0.025$) or were working ($p=0.022$) in Southern/Easter/Greater Europe. By contrast, older respondents ($p<0.001$) and those with longer clinical experience more frequently denied such need ($p=0.002$). Respondents confident in managing thermoregulatory disorders also less frequently reported autonomic educational needs ($p=0.004$). Autonomic specialists reported similar needs to increase their ANS knowledge compared to non-specialists. When combining gender, age and the European region of training in a multinomial regression model, female respondents (OR 5.196, 95% CI 1.063–25.386) and respondents below 45 years (OR 4.965, 95% CI 1.186–20.777) were more likely to report educational needs, whilst the region of training did not retain statistical significance.

Regarding the preferred autonomic educational format, respondents most frequently favored conference workshops ($n=185$, 65%), followed by webinars and other online educational formats, as well as a more structured integration of autonomic contents in the neurology residency curriculum (Table 3 and Figure 2c). The characteristics of the respondents were differently associated with their preferences for a specific autonomic educational format. People below 45 years old ($p<0.001$) and those with lower confidence in managing ANS disorders ($p=0.004$) more likely preferred the integration of autonomic contents in the residency curriculum, whilst respondents with higher confidence in autonomic medicine favored lectures at congresses ($p=0.017$). Respondents with lower levels of confidence in autonomic medicine reported preferences for scholarly reviews on the management of bladder ($p=0.008$) and sexual dysfunction ($p=0.003$), whilst it was felt that training in ophthalmological ($p=0.004$) and thermoregulatory ($p=0.003$) disorders should rather be part of residency programs.

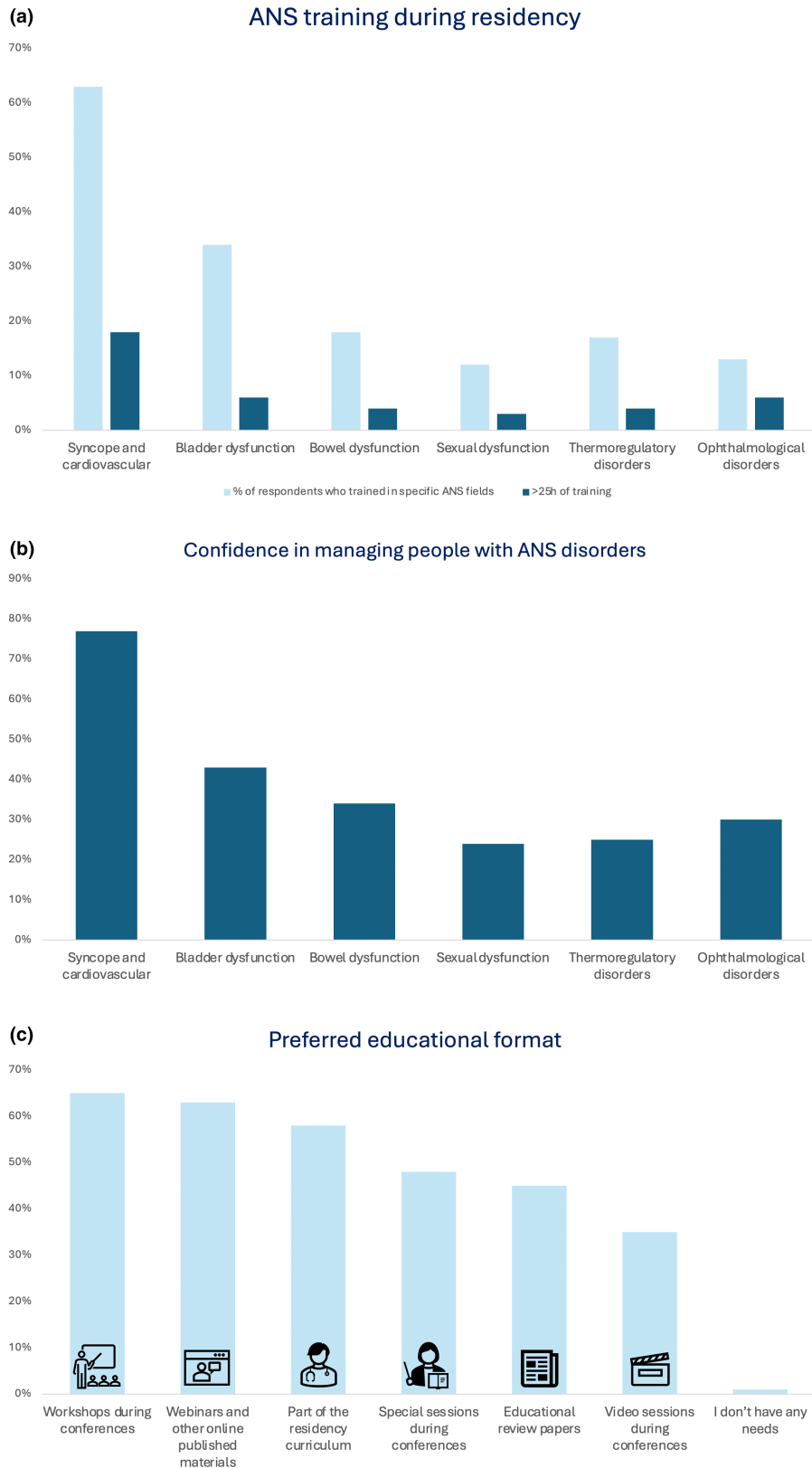


FIGURE 2 (a) Percentage of respondents who received training in specific ANS fields and percentage of respondents who had more than 25 h of training in that field. (b) Percentage of respondents who had a high level of confidence (i.e., rating their confidence >5 on a 1–10 scale) in managing different ANS disorders. (c) Preferred educational format of the survey respondents for improving their ANS skills.

Knowledge evaluation

Most respondents (66%, $n = 189$) answered correctly at least four out of six self-assessment multiple-choice questions on different ANS

TABLE 3 Personal confidence in managing ANS disorders and autonomic educational preferences.

In your opinion, how important are autonomic skills for a good neurological clinical practice?	
Not important	0 (0%)
Of little importance	0 (0%)
Moderately important	28 (10%)
Important	125 (44%)
Very important	132 (46%)
Confidence level in managing ANS disorders (i.e., ≤ 5 vs. > 5 on a 1–10 scale)	
Low level of confidence in all ANS fields	49 (17%)
High confidence level in one ANS field	80 (28%)
High confidence level in multiple ANS fields	156 (55%)
Do you feel you need to increase your knowledge about autonomic disorders?	
Yes	261 (92%)
No	11 (4%)
I don't know	13 (4%)

Abbreviation: ANS, autonomic nervous system.

domains (Table 4). Respondents with longer clinical experience more frequently answered correctly questions about orthostatic hypotension ($p = 0.042$), hypohidrosis ($p < 0.001$) and erectile dysfunction ($p = 0.047$). The question about hypohidrosis was more frequently answered correctly by older colleagues ($p < 0.001$) and with higher overall self-confidence in autonomic medicine ($p = 0.004$). Male respondents more frequently answered the question about orthostatic hypotension correctly ($p < 0.001$) and respondents who trained or work in Northern/Western Europe more frequently gave correct answers to the questions about orthostatic hypotension ($p < 0.001$) and erectile dysfunction ($p = 0.040$).

When comparing the number of correct answers with the formal autonomic training received during residency, no relevant association was observed. Respondents who had no autonomic training during residency gave similar numbers of correct answers to those who had it. Autonomic specialists had an overall better performance than non-specialists ($p = 0.031$).

DISCUSSION

Our study is the first of its kind delving into the critical area of autonomic education and sheds light on the skills and educational preferences of European neurology residents and consultants.

Previous EAN/EFAS studies revealed disparities in autonomic healthcare provision between Northern/Western Europe and

Self-assessment multiple-choice questions	No. of survey respondents giving the correct answer
Which clinical clues best help you distinguish between syncope and seizure? <i>Quick regain of consciousness after the event</i>	220 (77%)
What is the most common cause of orthostatic hypotension? <i>Medications</i>	169 (59%)
Which of the following drugs can cause hypohidrosis? <i>Amitriptyline</i>	190 (67%)
Which exam would you request first in a neurological patient reporting bladder complaints? <i>Urine dipstick</i>	110 (39%)
Which of the following drugs does not promote erection? <i>Metoprolol</i>	230 (81%)
Which of the following are not used for managing constipation? <i>Loperamide</i>	204 (72%)
Number of self-assessment multiple-choice questions correctly answered	$N = 285$
0	4 (1%)
1	14 (5%)
2	29 (10%)
3	49 (17%)
4	78 (27%)
5	74 (26%)
6	37 (13%)

TABLE 4 Knowledge evaluation in different autonomic domains.

Southern/Eastern/Greater Europe [4]. The present study shows that this gap also exists in autonomic education, with neurologists from Northern/Western European countries more frequently receiving the opportunity to rotate in autonomic units and to train in multiple autonomic domains during their residency. In a mirror fashion, it was observed that respondents from Southern/Eastern/Greater Europe more frequently considered skills in autonomic medicine of higher importance. Previous research on European neurology curricula mentioned the high variability between residency programs across countries, but had not captured such regional asymmetry yet [9, 12, 13]. In the autonomic field, this asymmetry is probably driven by the uneven distribution of autonomic units in Southern/Eastern/Greater versus Northern/Western Europe. Promoting a harmonization of autonomic healthcare provision, education and research across Europe, both EFAS and the EAN recently supported local autonomic scientists in expanding their network within the European autonomic community. This activity fostered the recent foundation of the Croatian and Romanian Autonomic Societies, which hosted the latest EFAS annual congresses and schools (<https://www.efasweb.com/net/index.php/efas-meetings/past-meetings>). Most respondents of the present survey were based in Romania and Croatia, suggesting that both the presence of a national autonomic society and the organization of scientific and educational autonomic meetings represent effective vehicles for an increased interest in ANS disorders in previously under-served countries.

Another gap was observed when analyzing survey responses provided by male versus female colleagues. Women considered ANS skills of higher importance, more frequently expressed their need to increase knowledge about ANS disorders and felt overall less confident in managing ANS disorders than men. This finding echoes previous research focusing on medical students and physicians at different stages of their career, where women consistently reported lower confidence levels than men, despite comparable performances and possibly a more favorable prognostic impact on hospitalized patients [14–16]. Such a gender gap is a call for action to mitigate gender asymmetries and their practical implications for the career development of future neurologists.

In recent years, the COVID-19 pandemic had a major impact on neurological healthcare provision, research and education throughout Europe [17, 18]. The influence was even deeper in the autonomic field, given the substantial number of individuals developing post-COVID autonomic disturbances and the time it took for autonomic centers to resume their activities after the repeated lock-downs and pandemic containment measures [5–7, 18, 19]. The COVID-19 pandemic, however, also provided momentum for the development of e-learning options such as webinars and other online-published materials, which hold promise for a more equitable, cross-border access to autonomic and other neurological subspecialty education [5], especially in those countries or regions without available referral centers. In the present survey, both European neurology residents and consultants deemed e-learning a valid and acceptable option for improving ANS skills, especially in those fields of autonomic medicine, like bladder and

sexual dysfunction, that are least frequently taught during training. Besides that, respondents below 45 years of age and those less confident in managing autonomic disorders expressed a clear preference for a structured integration of autonomic medicine in the residency curriculum to leverage their ANS skills. This aligns with the latest European training requirements for neurology that acknowledge autonomic medicine as one of the core areas in neurology and requires interventions at national and local level for increasing the amount of autonomic educational contents during neurology training.

Our survey also pinpointed that training in autonomic medicine currently mainly covers the cardiovascular domain, whilst the minority of respondents received training in other autonomic fields. Subjective confidence in managing some autonomic domains strongly depended on the amount of ANS training received. This observation indicates that autonomic education during training is a prerequisite for making neurologists feel confident in treating individuals with various ANS disorders. Interestingly, the only question that most of the respondents did not answer correctly concerned the initial management of bladder disturbances. This partially mismatched the confidence respondents reported to have for managing neurogenic bladder dysfunction and raises concern when it comes to clinical care. Respondents with less confidence in managing urinary disturbances tended to prefer scholarly reviews for improving their ANS skills. Anticipating such educational need, the EAN, EFAS and INUS are currently preparing a guideline on the diagnosis and treatment of neurogenic bladder and sexual dysfunction for the practicing neurologist (NEUROGED). The scope of such initiative is to provide neurologists with tools to best navigate the complex landscape of urogenital ANS disorders, especially if practicing outside of autonomic referral centers.

Finally, most respondents appreciated the importance of autonomic medicine and felt the need to improve their ANS skills. Such widespread opinion may result from the high prevalence of ANS disturbances in many neurological conditions and their impact on the quality of life of affected individuals, making ANS disorders a daily matter in clinical practice. Importantly, despite the abovementioned asymmetries in the autonomic educational offer received, most respondents performed well at the self-assessment of the personal autonomic skills. This suggests that also those colleagues not receiving any targeted training were notwithstanding educated on the principles of autonomic medicine during the course of their residency.

This study has limitations. First, some countries were not represented in the survey, and the number of participants per country did not match the country-specific neurologists/population ratio. Results reflected the opinions of the survey respondents, whilst no source data on the training curricula contents was consulted for the present study. The proportion of respondents specialized in autonomic medicine was also slightly higher than in previous EAN survey studies [11, 18] and it is possible that colleagues with a special interest in the ANS might have been more prone to answer the survey. Attention was paid, however, to phrase questions in a neutral

way and warrant the respondents' anonymity. To our own surprise, autonomic specialists in fact provided similar answers regarding the importance of autonomic skills, confidence level and need for additional autonomic education compared to non-specialists. The majority of the respondents were also specialized in stroke, movement disorders and multiple sclerosis, that is, the most frequent neurological subspecialties, overall indicating that the study cohort was sufficiently representative of the European subspecialty arena. There was a preponderance of younger respondents, and training settings may have changed over time or vary within the same country. The residents were also not specifically asked about the year of training, but it is acknowledged that the amount of training received and the confidence level probably diverge between junior and senior residents. The respondent's quote was higher amongst the EAN full members (i.e., consultants) compared to the residents. In some questions, for example regarding medical school, recall was needed, and answers might not have been fully exact, especially amongst the consultants who completed their studies decades ago. Finally, respondents reported their perceived personal competence, and no objective competence assessment was performed except for the self-assessment multiple choice questions.

Concluding, we found that there is a disparity in accessing autonomic education across European countries and that the limited amount of autonomic training received oftentimes made European neurology trainee and consultants feel less confident in managing autonomic disorders. This is a call for professional societies and academic institutions to increase the autonomic educational content both at pre-graduate and postgraduate level.

AUTHOR CONTRIBUTIONS

Diogo Reis-Carneiro: Conceptualization; supervision; writing – original draft; investigation; methodology; formal analysis; data curation. **Magdalena Krbot Skoric:** Investigation; writing – review and editing; methodology; formal analysis. **Mario Habek:** Writing – review and editing; conceptualization; investigation. **Ivan Adamec:** Writing – review and editing; investigation. **Giovanna Calandra-Buonaura:** Writing – review and editing; investigation. **Pietro Cortelli:** Writing – review and editing; investigation. **J. Gert van Dijk:** Writing – review and editing; investigation. **Cristian Falup-Pecurariu:** Writing – review and editing; investigation. **Pietro Guaraldi:** Writing – review and editing; investigation. **Max J. Hilz:** Writing – review and editing; investigation. **Valeria Iodice:** Writing – review and editing; investigation. **Jens Jordan:** Writing – review and editing; investigation. **Isabel Rocha:** Writing – review and editing; investigation. **Walter Struhal:** Writing – review and editing; conceptualization; investigation. **Astrid Juhl Terkelsen:** Writing – review and editing; investigation. **Roland Thijs:** Writing – review and editing; conceptualization; investigation. **Beatriz Tijero:** Writing – review and editing; investigation. **Thomas Berger:** Writing – review and editing; investigation. **Irena Rektorova:** Writing – review and editing; investigation. **Elena Moro:** Writing – review and editing; investigation. **Anne Pavy-Le Traon:** Writing – review and editing; investigation. **Gregor Wenning:** Writing – review and editing; investigation. **Jalesh N. Panicker:** Writing – review

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DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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